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TITLE: Switching beam array system for cdma system

INVENTOR: SIM, D H

PATENT-ASSIGNEE: LG ELECTRONICS INC[GLDS]

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ABSTRACTED-PUB-NO: KR2002024876A

BASIC-ABSTRACT:

NOVELTY - A switching beam array system for a CDMA system is

provided to
generate an optimum beam pattern according to the environmental change of a
telecommunication system by minimizing the influence of interference signals
using the temporal/spatial processes.

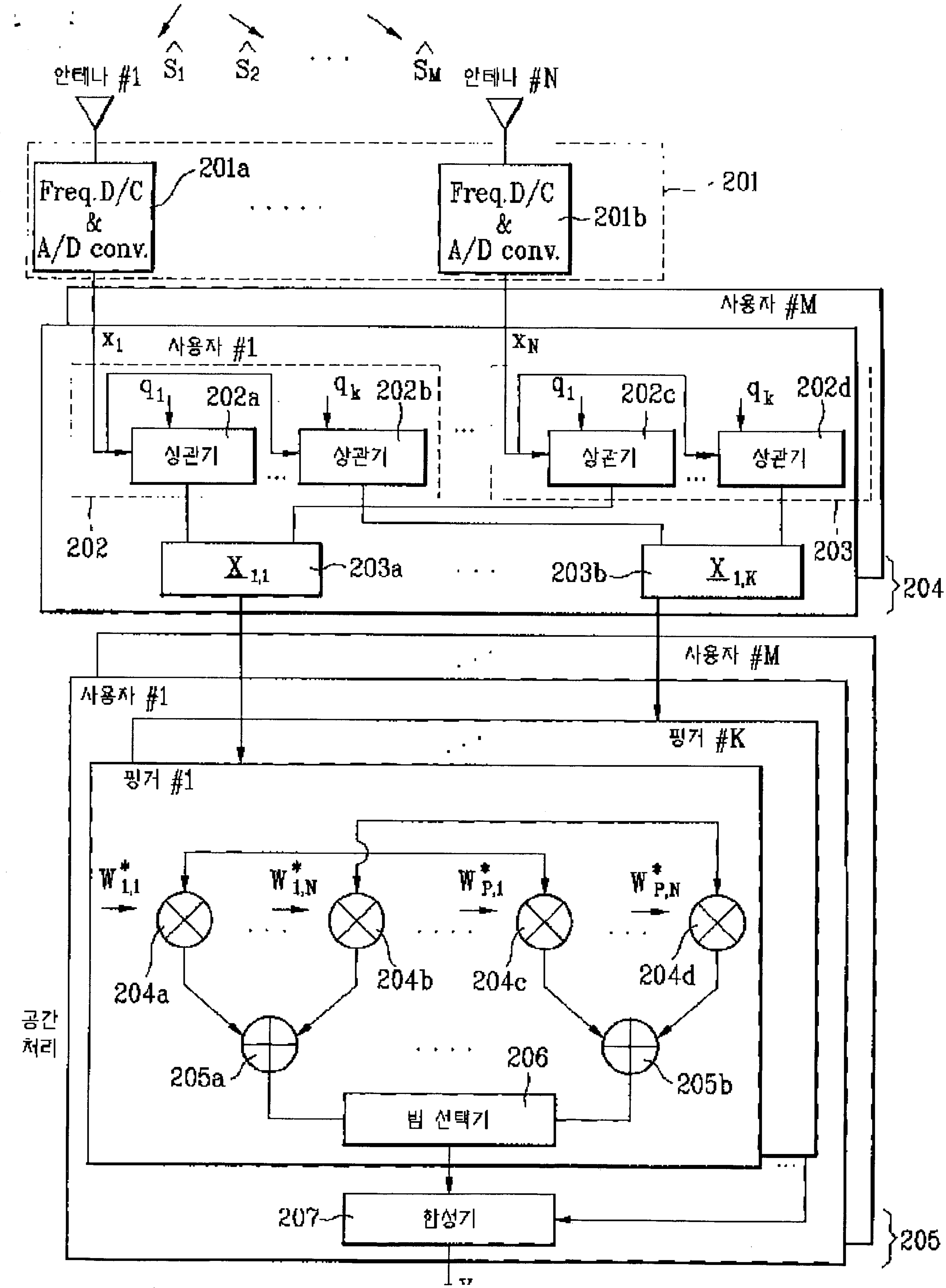
DETAILED DESCRIPTION - A converting unit(201) comprises a frequency down
converter converting ultra high frequency signals into base band signals, and
A/D converters(201a,201b) converting analog signals into digital signals. A
rake receiver(204) is provided for a temporal process including the dispreading
of the digital signals. A beam generator(205) is provided for a spatial
process of a receipt signal vector output from the rake receiver(204). A
digital demodulator demodulates digital signals temporally/spatially processed
by the rake receiver(204) and beam generator(205).

CHOSEN-DRAWING: Dwg.1/10

TITLE-TERMS: SWITCH BEAM ARRAY SYSTEM CDMA SYSTEM

DERWENT-CLASS: W02

EPI-CODES: W02-B06B;



안테나 #1
$\hat{S}_1$
$\hat{S}_2$
$\hat{S}_M$
안테나 #N
Freq.D/C & A/D conv.
201a
Freq.D/C & A/D conv.
201b
201
사용자 #M
x_1
사용자 #1
x_N
q_1
202a
q_k
202b
q_1
202c
q_k
202d
상관기
상관기
상관기
상관기
202
203
$X_{1,1}$
203a
203b
$X_{1,K}$
204
사용자 #M
사용자 #1
핑거 #K
핑거 #1
$W^*_{1,1}$
$W^*_{1,N}$
$W^*_{P,1}$
$W^*_{P,N}$
204a
204b
204c
204d
공간 처리
205a
205b
206
빔 선택기
207
합성기
205

PTO 04-[4116]

Korean Patent

2002-0024876

SWITCHING BEAM ARRAY SYSTEM

FOR CODE DIVISION MULTICONNECTION SYSTEM

[Code Bunhal Tajung Jeopsok Systemul Wihan

Swithing Beam Array System]

Dong-Hee Shim

UNITED STATES PATENT AND TRADEMARK OFFICE

Washington, D.C. July 2004

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Foreign Language Title	:	Code Bunhal Tajung Jeopsok Systemul Wihan Swithing Beam Array System
English Title	:	SWITCHING BEAM ARRAY SYSTEM FOR CODE DIVISION MULTICONNECTION SYSTEM

/1[1]

Specification

Brief description of the figures

Figure 1 shows an array antenna system when a switching beam array antenna is used in a backward channel of a conventional mobile communication system.

Figure 2 shows the switching beam array antenna system of the present invention.

Explanation of symbols of the main parts of the figures

201 Conversion part

201a, 201b Frequency down converter and analogue digital converter (Freq. D/C & A/D conv.)

202, 203 Collator sets

204 Rake receiver

202a-202d Collators

205 Beam formation part

203a, 203b Receiving signal vector generators

204a-204d Multipliers

205a, 205b Adders

206 Beam selector

[1] Numbers in the margin indicate pagination in the foreign text.

207 Synthesizer

Detailed explanation of the invention

(Purpose of the invention) /2

(Technical field of the invention and prior art)

The present invention pertains to a smart antenna. In particular, the present invention pertains to a switching beam array system for a code division multiconnection system that simultaneously carries out a time processing and a space processing to overcome a signal fading phenomenon in a code division multiconnection (CDMA) system environment.

In a general preferential communication, a desired signal (hereinafter, called "desired signal") and interference signals exist in receiving signals, and a number of interference signals usually exist for one desired signal. Since the degree of communication disturbance due to these interference signals is determined by the total of all the interference signal powers to the desired signal power, even if the level of the desired signal is much higher than the level of each of the interference signal, the total power of the interference signals is increased when the number of interference signal is large, so that a communication disturbance is generated.

Therefore, in conventional cellular mobile communication systems, it is focused to minimize these interference signals by using a smart antenna. In other words, when a mobile body moves or the angle of arrival of its signal is variable in accordance with situations, in order to detect the positions of remote signal sources by using an array consisting of various antenna elements or to selectively transmit and receive signals being output from the antenna elements, the phase of the antenna arranged is controlled, specific signals (remote signals) are selectively transmitted and received, and the influence of interference signals is minimized, so that the interference among subscribers is largely reduced.

Figure 1 shows an array antenna system when a switching beam array antenna is used in a backward channel of a conventional mobile communication system.

In Figure 1, the conventional switching beam array consists of several beam generators (101-103) for generating fixed beams and a beam selector (104).

The above-mentioned beam generators (101-103) are devices fro generating fixed beams at an optional angle of incidence of receives signals of the antenna array, and each beam generator (101-103) generates fixed beam patterns at different angles of incidences. Therefore, the beam selector (104) adopts a method

that selects the beam generators (101-103) so that the influence of interference signals on a desired signal may be minimized in accordance with the angles of incidence of the received signals in the antenna array.

The operations of the above-mentioned beam generators (101-103) and beam selector (104) are explained in detail in the following reference cited.

[Reference cited]

William C.Y. Lee, An optimum solution of the switching beam antenna system, proceedings of IEEE 47th Vehicular Technology Conference, 1997, Vol. 1, pp.170-172

However, in the technique using the switching beam array in the backward channel in the conventional mobile communication system, since only the method for selecting one pattern among several fixed beam patterns through the beam selector is used, there is a difficulty in generating an optimum beam pattern owing to the deterioration of a channel environment such as fading through only the space processing.

In other words, it is difficult to generate an optimum beam pattern for minimizing the influence of interference signals by the method that carries out only the space processing.

(Technical problems to be solved by the invention)

Therefore, the present invention has been created in consideration of the above-mentioned prior art, and its purpose is to provide a switching beam array antenna system in a code division multiconnection system that generates an optimum beam pattern in accordance with environmental changes of a communication system.

In order to achieve the above purpose, the device of the present invention is characterized by consisting of a rake receiver that separates signals being received through a multipath from an optional user and generates receiving signal vectors and a beam generation part that generates an optional number of beam patterns by the complex inner product of the above-mentioned each receiving signal vector and a weight vector, synthesizes each optimum beam pattern for the above-mentioned receiving signal vectors among these beam patterns, and outputs it.

Preferably, the above-mentioned rake receiver is characterized by being equipped with several collators sets consisting of lots of collators and separate signals received via the above-mentioned multipath and output them and several receiving signal vector generators that synthesize the signals passed through the collators with the same sequence in the

above-mentioned collator sets and generate receiving signal vectors.

Also, the above-mentioned beam generation part is characterized by being equipped with multipliers that generates an optional number of beam pattern by the complex inner product of each receiving signal vector generated from the above-mentioned receiving signal vector generator and a weight vector and a synthesizer that synthesizes each optimum beam pattern of the receiving signal vectors among the beam patterns of the above-mentioned receiving signal vectors and output it.

(Constitution and operation of the invention)

The present invention embodies an antenna array system being applied to a code division multiconnection system and proposes an antenna array system that carries out a time processing as many as fingers in each antenna by using a rake receiver of an existing code division multiconnection system, constitutes signals time-processed in each finger by receiving signal vectors having component as many as the number of antenna, carries out a space processing as many as the number of each finger, and forms an optimum beam pattern.

Next, the constitution and operation of a preferred application example of the present invention is explained referring to the attached figures.

Figure 2 shows the switching beam array antenna system of the present invention.

In Figure 2, in realizing a time-space processing /3 adaptive array antenna for the code division multiconnection (COMA) system, the present invention consists of a conversion part (201) including a frequency down converter for converting a very high-frequency signal into a base band region and an analogue-digital converter (A/D converter) (201a, 201b) for converting an analogue signal into a digital signal, a rake receiver (204) for time-processing including dispreading of the above-mentioned digital signal, a beam formation part (205) for space-processing the receiving signal vectors output from the above-mentioned rake receiver (204), and a digital demodulator (not shown in the figure) for demodulating the digital signal after the time-space processing by the above-mentioned rake receiver (204) and beam formation part (205).

The above-mentioned conversion part (201) receives signals being received via a multipath through N pieces of antenna from an optional user, is equipped with the frequency down converter and the analogue digital converter (A/D converter) (201a, 201b) as many as N pieces of antennas, converts very high-frequency signals received by the above-mentioned N pieces of antenna into

base band signals, and converts the analogue signals of the base band into digital signals.

The above-mentioned rake receiver (204) forms k pieces of receiving signal vectors by using (k+N) pieces of collators (202a-202d) for each of N pieces of receiving signals from the above-mentioned frequency down converter and analogue signal converter (A/D converter))(201a, 201b). In other words, the above-mentioned collators (202a, 202b) receive the signals transmitted via the multipath from the above-mentioned optional user by N pieces of antenna, recognize these signals as independent signals, though they are signals transmitted at a different time from the same user, and separate them.

k pieces of collators consisting of 202a and 202b or k pieces of collators consisting of 202c and 202d among the above-mentioned collators (202a-202d) respectively constitute one collator set (202, 203), time-process the above-mentioned N pieces of receiving signals, and output them to the receiving signal vector generators (203a, 203b).

In other words, among the above-mentioned N pieces of receiving signals, the signals passed through the k-th same collator (202a and 202c or 202b and 202d) and time-processed are respectively set in the receiving signal vector generators (203a, 203b) and form one receiving signal vector with a size of

1 x N. Therefore, as the receiving signal vector, k pieces of signal vectors are formed, and for an optional user (M), k pieces of receiving signal vectors are also similarly formed.

k pieces of receiving signal vectors generated from the above-mentioned are respectively input into each multiplier (204a-204d) of the beam generation part (205), processed as a complex inner product with a weight vector, added to adders (205a, 205b), and formed as P pieces of beam patterns. In other words, the above-mentioned weight vector has a size of N x 1, processed as a complex inner product with optional receiving signal vectors generated from the above-mentioned receiving signal vector generators (203a, 203b), and formed as P pieces of beam patterns. Since P pieces of beam patterns are formed for each of k pieces of receiving signal vectors, an optimum beam pattern with the smallest influence of the interference signals among P pieces of beam patterns is selected by a beam selector (206). Since the optimum beam pattern selected is realized for all of k pieces of receiving signal vectors, all the above-mentioned selected optimum beam patterns are set in a synthesizer (207), and an output signal of the switching beam array antenna system is finally output.

In Figure 2, the number of antenna for generating a switching beam pattern is set to N pieces, the rake receiver

(204) for a time processing has k pieces of fingers (collators), and signals despread from the fingers (collators) with the same sequence are constituted as signal vectors in the receiving signals of each antenna. It is called N.

Then, the signals of the first finger (or collator) of each antenna are collected and constitute a signal vector $N_{1,1}$, and the signals of the second finger (or collator) are collected and constitute a signal vector $N_{1,2}$. Using this method, M x k pieces of receiving signal vector $N_{M,k}$ formed from k piece of fingers from M subscribers are respectively constituted.

In the above-mentioned $N_{M,k}$, the subscription M indicates a user index and has an incremental value from 1 to M. The above-mentioned subscription k indicates a finger index and has an incremental value from 1 to k. Also, $N_{1,1}$-$N_{M,k}$ are N x 1 of signal vectors in which signals of the first antenna to the N-th antenna are collected, since the signals of each antenna element are reflected.

Then, the weight vector of the switching beam array for a space processing of the beam generation part (205) being multiplied to the signal vector N is called W.

If it is assumed that P pieces of beam patterns of the switching beam are used, the weight vector being used in these beam patterns receive the receiving signal vectors from the

above-mentioned each k piece of finger, and the weight vector from $W_{1,1}$ to $W_{P,N}$ is multiplied to each of these receiving signal vector, so that P pieces of beam patterns are generated fro each of receiving signal vector. Among these beam patterns, the signal with an optimum beam pattern, that is, the signal with the smallest influence of interference signals is selected by the beam selector (206). Since all the above-mentioned optimum beam patterns are selected one by one for k pieces of signals, the optimum beam patterns selected are synthesized by the synthesizer (207), and an output signal y_1 of the optimum switching beam array antenna system is finally output.

In the above-mentioned $W_{P,N}$, the subscription P indicates a beam pattern index of the switching beam, and the subscription N indicates an index of the antenna. Also, y_1 shows all the results of the time processing and the space processing in the code division multiconnection system for the first user. In other words, the subscription 1 of y_1 indicates the first user as an index for sequentially classifying M persons in a base station of the code division multiconnection system.

In the above-mentioned present invention, since the switching beam array is used, the beam patterns fixed in advance by this array are identically applied to any users.

As a result, the signals of specific users are separated into set codes of the code division multiconnection system through K pieces of fingers (or collators) for a time processing, and in order to spatially process the signals of each finger, K pieces of signal vectors including the signal components of each antenna are processed as an inner product /4 with P pieces of set beam patterns for the signals of each finger. The largest value is selected for each finger, and K pieces of output value derived are coupled through the synthesizer, so that a final antenna array output is attained.

In other words, the present invention can be said as a structure that time-processes the output of each finger of the rake receiver (202) in an existing code division multiconnection system and couples them after space-processing the signals of each finger.

(Effects of the invention)

As explained above, in the present invention, even in case incident signals constituting receiving signal vectors time-processed in each finger of the rake receiver are incident in different directions, they can be classified through beam patterns of a preset switching beam.

Also, even if lots of beam patterns of the switching beam are set, since they are time-processed in advance, the number of

collator is not increased with the increase of the beam pattern of the switching beam (that is, even if relatively dense beam patterns are set by increasing the beam patterns of the switching beam).

Also, in an adaptive array using an adaptive algorithm, each different beam pattern must be set by implementing the adaptive algorithm for each user. However, in the present invention, since the switching beam array is used, P pieces of fixed beam patterns are identically applied to M persons, so that the amount being calculated can be markedly reduced, compared with the adaptive antenna using the adaptive algorithm.

Therefore, in case the present invention is applied to the code division multiconnection system, compared with the conventional code division multiconnection system in which only the time processing is implemented using a signal antenna, the space processing is implemented after the time processing using lots of antennas, and signals incident in different directions can also be classified in the space, so that communication qualities can be improved.

Through the above-mentioned contents, the party concerned can understand that the present invention can be variously changed and modified in the range where the technical concept of the present invention is not deviated.

Therefore, the technical range of the present invention should not be limited to the contents described in the application example but should be determined by the patent claims scope.

Claims

1. A switching beam array antenna system for a code division multiconnection system, characterized by consisting of a rake receiver that separates signals being received through a multipath from an optional user and generates receiving signal vectors; and a beam generation part that generates an optional number of beam patterns by the complex inner product of the above-mentioned each receiving signal vector and a weight vector, synthesizes each optimum beam pattern for the above-mentioned receiving signal vectors among these beam patterns, and outputs it.

2. The switching beam array antenna system for a code division multiconnection system of Claim 1, characterized by the fact that

the above-mentioned rake receiver is equipped with several collators sets consisting of lots of collators and separate signals received via the above-mentioned multipath and output them; and several receiving signal vector generators that

synthesize the signals passed through the collators with the same sequence in the above-mentioned collator sets and generate receiving signal vectors.

3. The switching beam array antenna system for a code division multiconnection system of Claim 1, characterized by the fact that

the above-mentioned beam generation part is equipped with multipliers that generates an optional number of beam pattern by the complex inner product of each receiving signal vector generated from the above-mentioned receiving signal vector generator and a weight vector; and a synthesizer that synthesizes each optimum beam pattern of the receiving signal vectors among the beam patterns of the above-mentioned receiving signal vectors and output it.

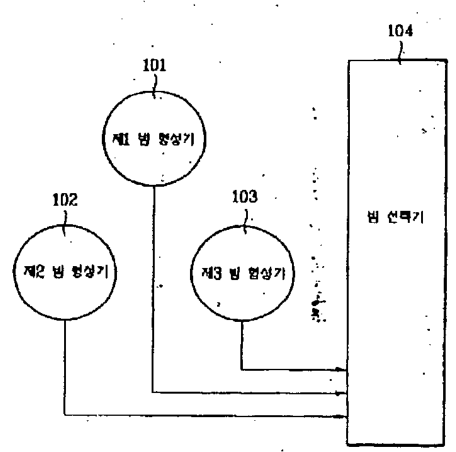

Figure 1:

101 First beam generator

102 Second beam generator

103 Third beam generator

104 Beam selector

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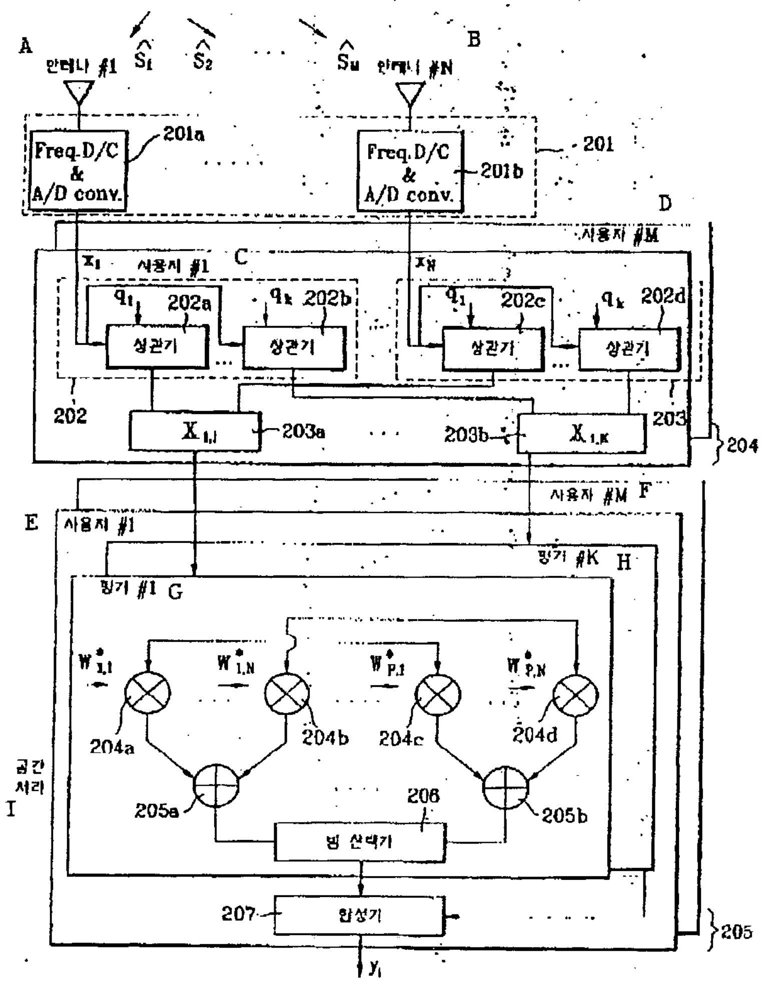

Figure 2:

202a Collator

202b Collator

202c Collator

202d Collator

206 Beam selector

207 Synthesizer

A. Antenna #1

B. Antenna #N

C. User #1

D. User #M

E. User #1

F. User #M

G. Finger #1

H. Finger #K

I. Space processing